

SAM Fall Technical Meeting  
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Results of Vapor Pathway Investigation  
of Homes over Petroleum Impacted  
Soils

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# Hydrocarbon Vapor Pathway Important Industry Issues

- ◆ Development of oil field and retail sites will continue to be priorities.
- ◆ More information is needed on good sample collection and analytical techniques.
- ◆ More good field data is needed to validate and refine the models.
- ◆ Consistent regulatory guidance is needed.
- ◆ Appropriate attenuation factors need to be used.

# Case Studies Summary

- ◆ A total of 7 case studies have been completed for homes within the Santa Maria Valley Oil & Gas field
- ◆ All sites are near historical oil production wells and/or associated sump and tank batteries
- ◆ Homes were constructed in early to mid 1990's

# Site Conditions

- ◆ Surficial soils are silty sands, moisture content highly variable as a function of irrigation
- ◆ Screened soils were used as backfill on some sites and contained small < 0.5 inch diameter clasts of asphaltic material
- ◆ Soils were compacted to greater than 90% prior to construction
- ◆ Topsoil and subsoil were mixed prior to construction of homes
- ◆ Most homes had TPH values in soils much less than 100 ppm while one home had values up to 57,000 ppm at a depth of 10 feet

# Some Site Issues

- 1) Homeowners at two sites claim elevated methane levels are killing plants
- 2) Homeowners claim high methane levels in soils may be cause for concern to indoor air
- 3) Homeowners hire attorney and consultant to collect data and threaten lawsuit
- 4) Concerns about property values
- 5) Local and regional press cover the issue
- 6) Local regulators approved all development

# Site Workplan for Each Property

- ◆ Collect vertical soil gas profiles in front and back yard to depth of 10 ft and under slab to depth of 5 ft-analyze for fixed gases and  $H_2S$ .
- ◆ Collect soil samples from vertical profiles at two locations to depth of 10 ft-analyze for TPH and physical properties.
- ◆ Collect soil data necessary to evaluate cause(s) of plant stress
- ◆ Collect isotopic data on soil gases to evaluate source and age



# Preparing Soil for Construction



# Healthy & Dead Plants in Park





# Soil Evaluation-Homeowners plants were stressed



# Results of Plant Stress Evaluation

- ◆ Tree roots confined to upper 4 inches of soil
- ◆ No evidence of topsoil
- ◆ Reducing conditions noted below 17 inches
- ◆ Penetrometer readings: 3.5-4.5 tons/ft<sup>2</sup>  
(good garden soil = 0.5 tons/ft<sup>2</sup>)
- ◆ Percolation rates=152-176 minutes/inch @ 6  
inch depth (rate above 60 is too poorly  
drained for septic leach field)
- ◆ All dead shrubs in adjacent park are in wet  
poorly drained soils

# Soil Physical Properties

- Very homogenous fine sand
- Soil moisture uniformly low (7.6%)
- Bulk and grain density values are in extremely narrow range-homogenous soils
- Aver. Bulk density=1.70 g/cc well above 1.65 where soils are considered compacted
- Total and air filled porosity noticeably increases in shallow soils (15% to 26%)
- TOC using Walkey-Black method averaged 3800 mg/kg
- High air permeability (2300 millidarcies)
- Hydraulic conductivity averages  $2.6 \times 10^{-5}$

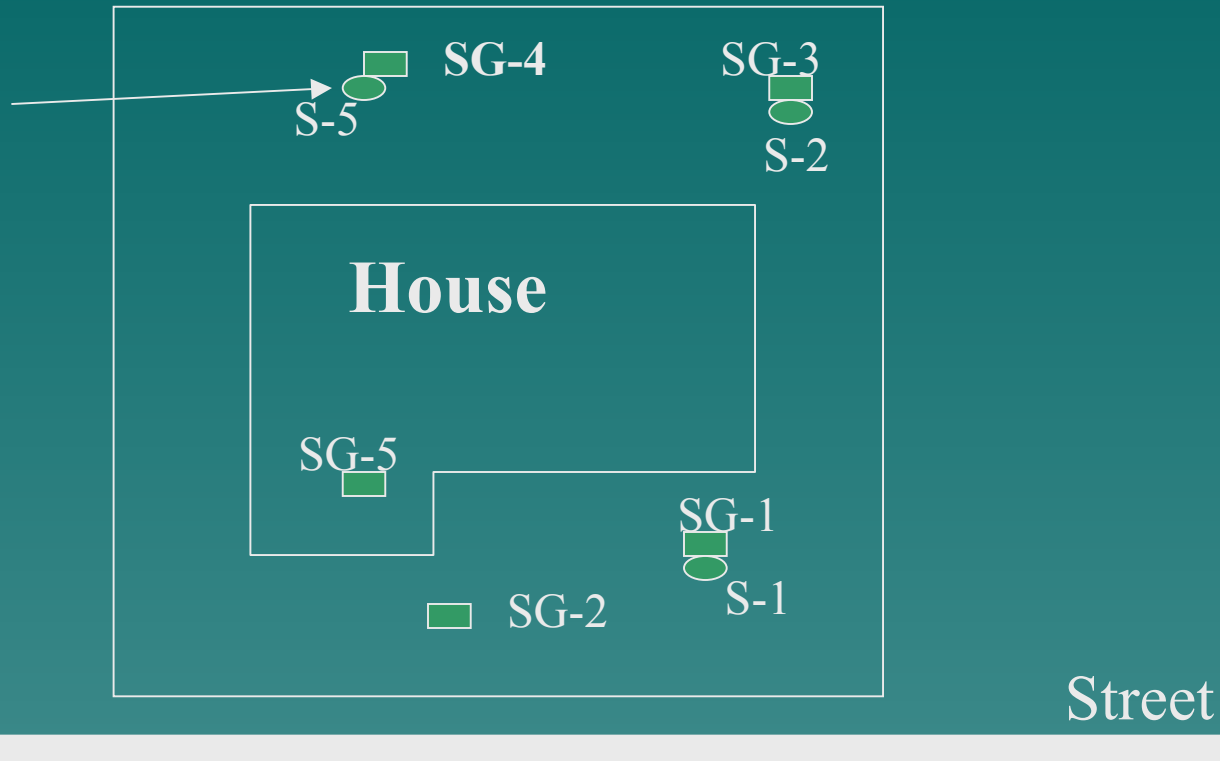


# Direct Push Soil Gas Sampling





Isotope  
Sample



Location of soil gas (SG) and soil (S) samples collected at Site 1 in Santa Maria, CA.

# Subslab Sampling in Garage



# Soil Gas Sampling Results

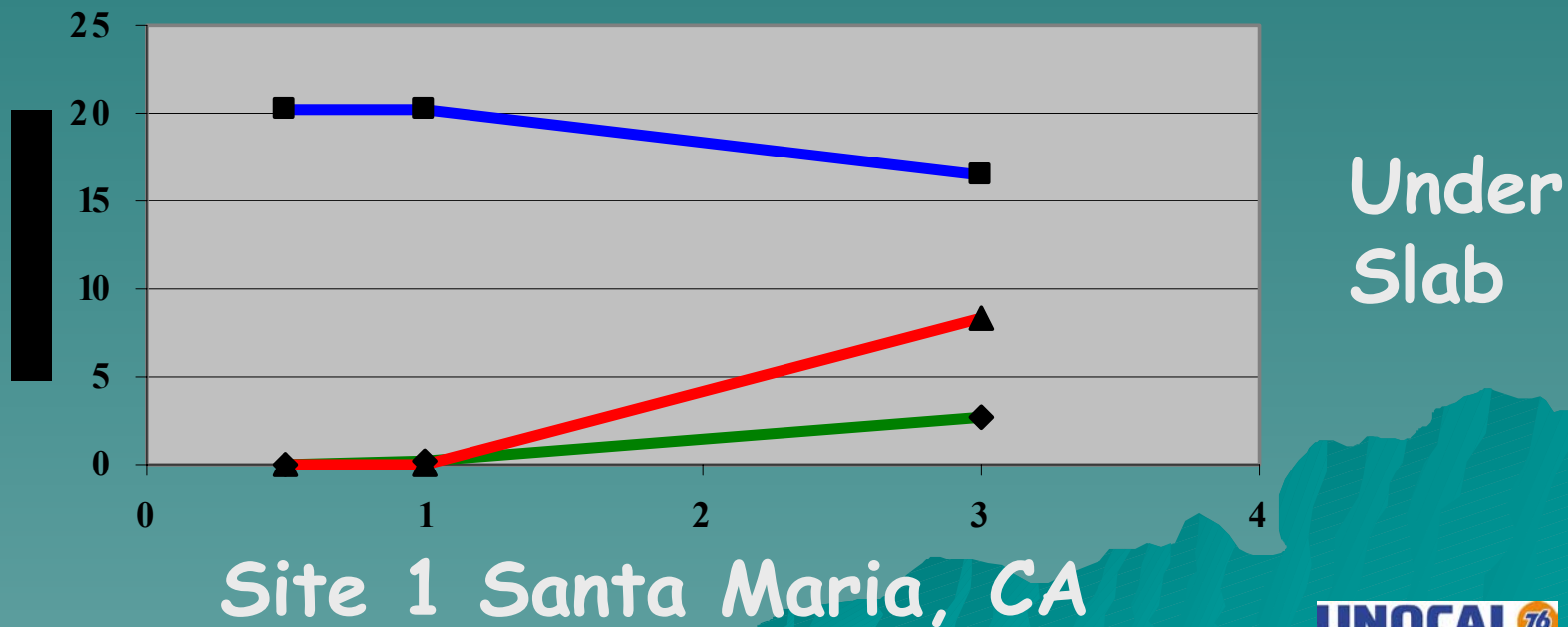
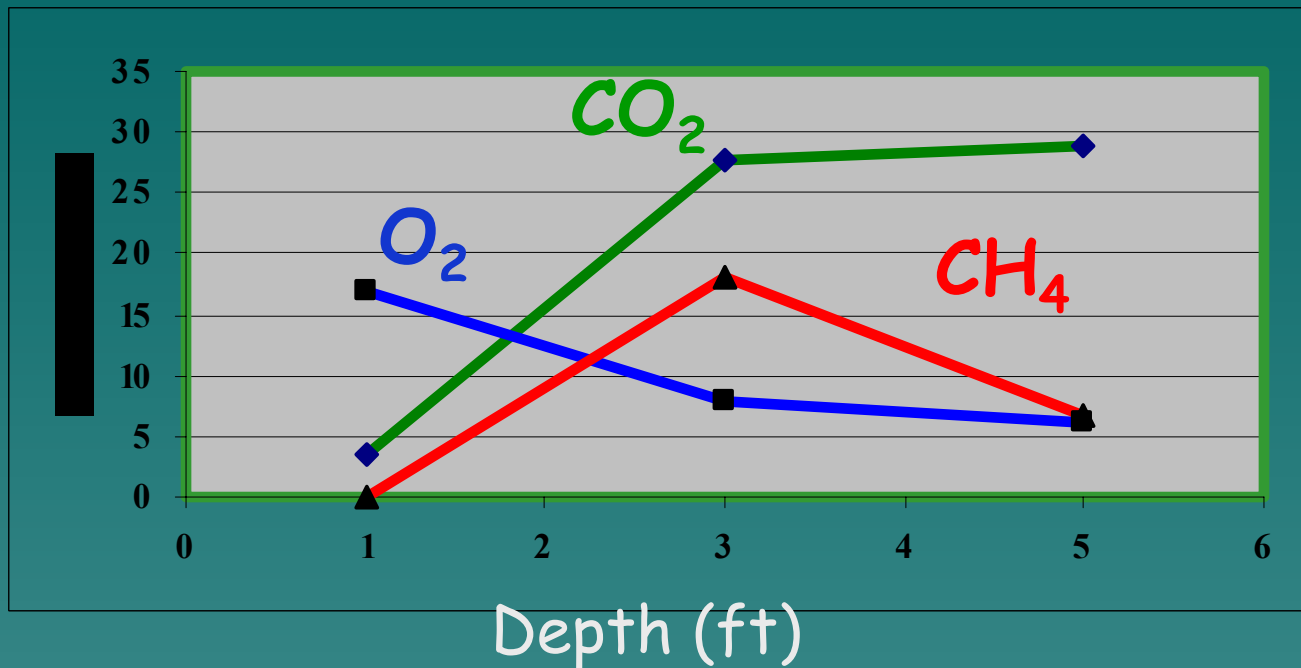
## Site 1

Sample depth	Methane (ppmv)
1. 0.5 ft below slab	12
2. 3 ft below slab	8,300
3. Outside 1ft	1,700
4. Outside 3ft	180,000

## Site 2

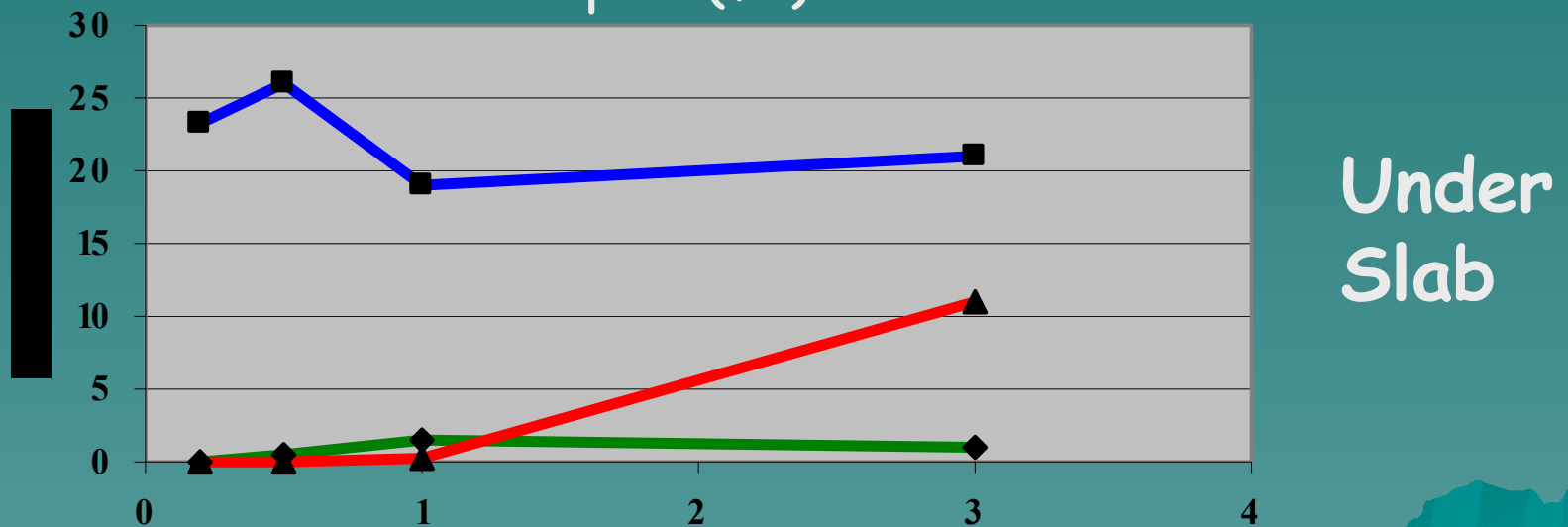
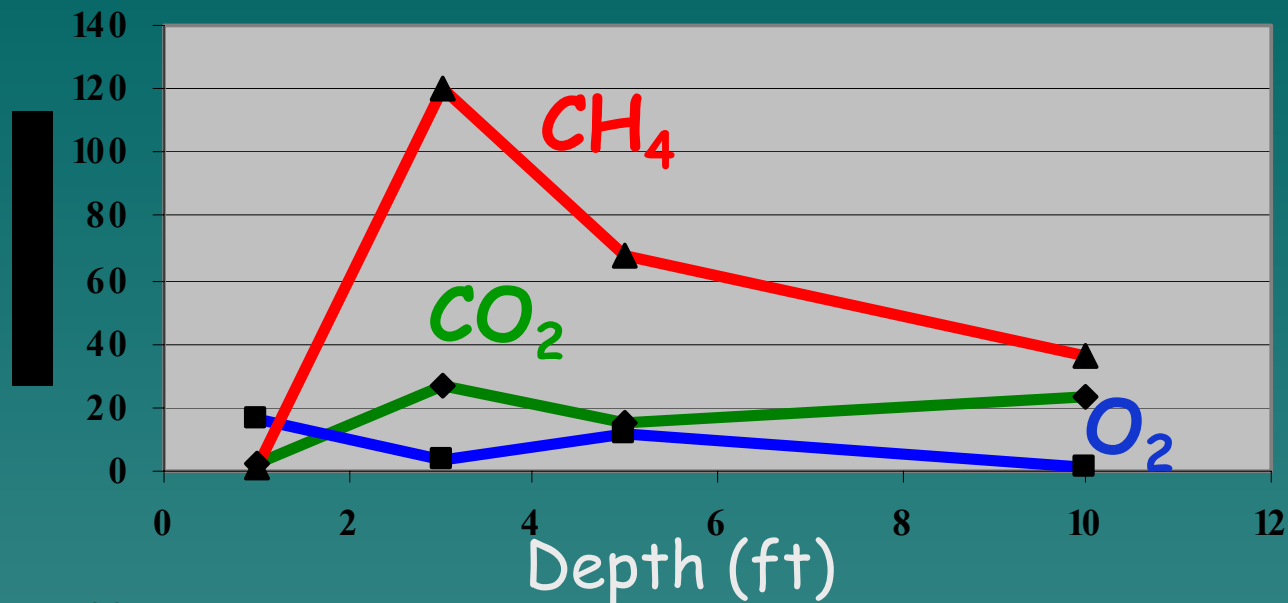
Sample depth	Methane (ppmv)
1. 0.5 ft below slab	<10
2. 3 ft below slab	11,000
3. Outside 1ft	45
4. Outside 5ft	120,000

# Soil Gas Vertical Profiles





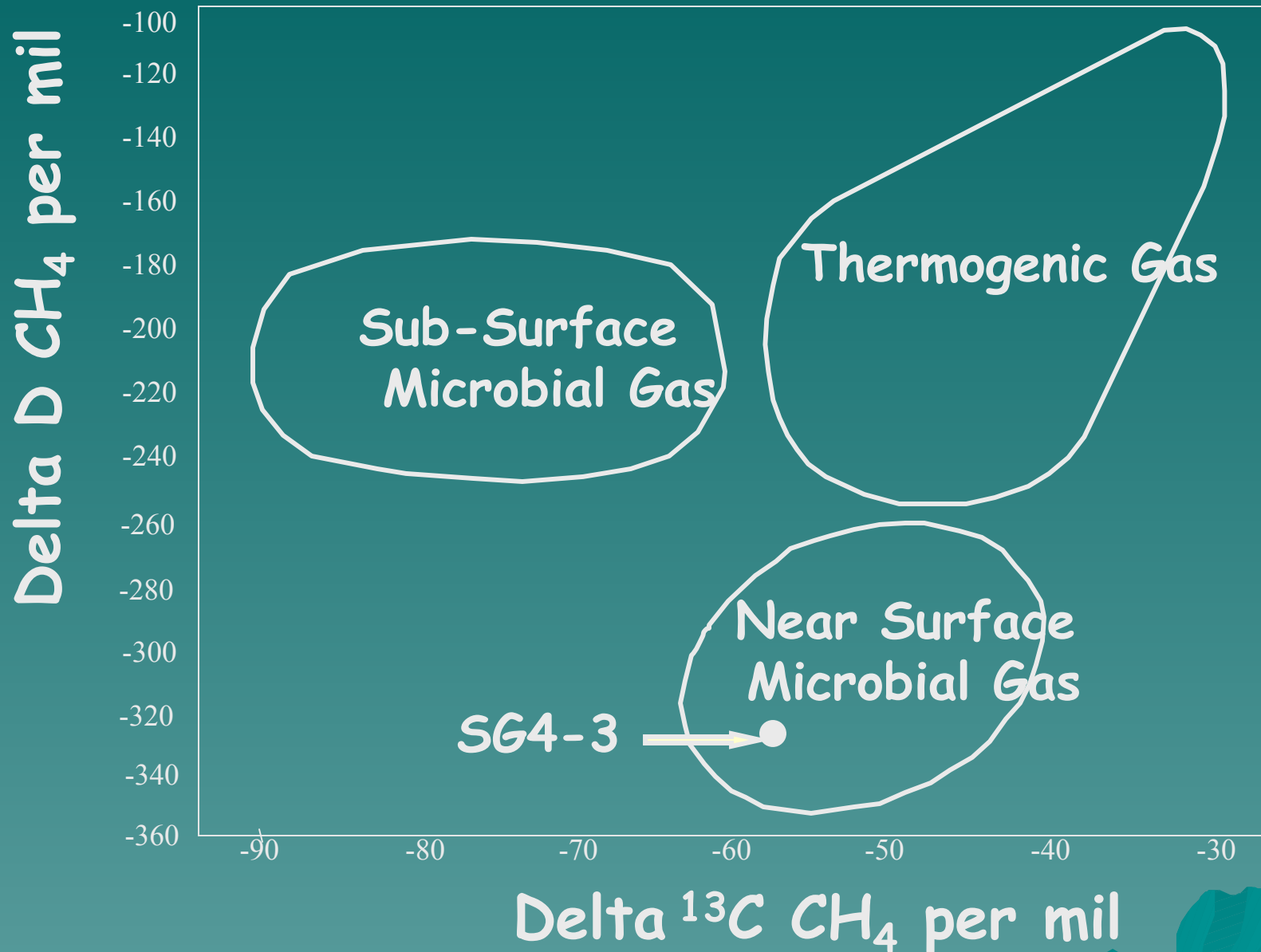
# Soil Gas Vertical Profiles



Site 2 Santa Maria, CA

# Analysis of Soil Gas Data

- ◆ No complete pathway is present in any vertical profile collected-high oxygen concentrations at all depths of two feet or less
- ◆ Using EPA guidance for estimating vapor intrusion at two typical sites:
  - ✓ Calculated values are 2,000 to 3,000 times below LEL using highest methane below slab
  - ✓ Calculated values are more than 50,000 times below LEL for samples measured directly below the slab



Sources of gases as defined in Coleman (1994)

# Conclusions

- ◆ Plant stress is result of highly compacted soils
- ◆ Methane is biogenic gas produced by relatively recent microbiological activity
- ◆ Process driving upward migration of methane is diffusion (no pressure drive)
- ◆ No complete vertical pathway exists for upward migrating methane
- ◆ No measurable hydrocarbon gases in indoor air
- ◆ No risk for hydrocarbon gases to accumulate to levels that pose a risk to human health or safety



# Isotech Gas Data SG-4

- ◆  $O_2 = 2.54\%$
- ◆  $CO_2 = 35.19\%$
- ◆  $N_2 = 38.9\%$
- ◆  $C1 = 22.9\%$
- ◆  $C2 \text{ through } C6+ = 0\%$
- ◆  $\Delta^{13}C1 = -57.18 \text{ per mil}$
- ◆  $\Delta DC1 = -328.4 \text{ per mil}$
- ◆  $^{14}C \text{ pMC} = 109\%$

# Discussion Points

- ◆ Effect of asphaltic chips on TPH values as measured by two different techniques
- ◆ Effect of moisture barriers on methane contents in shallow soils
- ◆ High concentration vs low volume
- ◆ Under slab vs outside slab soil gas
- ◆ Sources of methane-young organic matter can generate methane quickly